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**I**  
**NOTES ON**  
**LOWER TERTIARY DEPOSITS OF COLOMBIA**  
**AND THEIR**  
**MOLLUSCAN AND FORAMINIFERAL FAUNA**

**BY**  
**F. M. ANDERSON**  
*Honorary Curator, Department of Paleontology*

**INTRODUCTION**

Tertiary deposits are widely spread throughout the general area of the northern Andes in Colombia and Venezuela, occupying extensive basins in the present drainage systems of Lake Maracaibo, the Orinoco, and the Magdalena rivers. The chief interest of this paper centers in the early Tertiary deposits of the Magdalena and its tributaries, and especially in those of the Eocene and their environments.

It would appear from the distribution, materials and structural features of the earliest Tertiary known here, and their relations to the later Cretaceous formations, that their habitat was already prepared for them prior to their deposition. Extensive earth movements, folding and faulting of the older rocks, accompanied by uplift and denudation, had taken place before the close of Cretaceous time, and a great system of valleys with intervening ranges of mountains and coastal lowlands had been developed, into which, or upon which, the sea

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was led by early Tertiary subsidence, spreading contemporaneous deposits far inland.

From a study of the estuarine and non-marine Eocene (and Oligocene ?) deposits of Colombia, it appears that the surface relief of this region during the early Tertiary was not high, that the climate, while moist, was without excessive precipitation, and the country perhaps well forested.

The drainage basin of the Magdalena and its environs now present a varied topographic and geologic composition, a complete study of which would doubtless furnish the basis for a study of the neighboring basins and in large part the intervening Andean mountain system. The Tertiary deposits within the drainage area of the Magdalena range in age from early or middle Eocene to Pleistocene, and in character from clearly marine strata through estuarine to purely lacustrine and land-laid beds.

On the basis of the various facies of these deposits, as well as that of present and past topographic conditions, the valley of the Magdalena itself may be divided into three distinct sections, constituting the lower, central and upper valleys of the river. The valley between El Banco and the coast could be subdivided, but for the present will be known as the lower valley.

The central valley extends from El Banco southward to the narrows above the Rio Nare. The upper valley extends southward from Honda to far above Neiva, or in fact, to where the valley closes to a mere cañon.

#### BASEMENT ROCKS

The basement upon which the Tertiary deposits rest differs in different parts of the country. In the interior, about the non-marine and estuarine provinces, the basement rocks include Cretaceous strata, granitoid and other crystalline rocks, and semi-metamorphic slates, limestones and quartzites. Crystalline rocks outcrop along a low range of hills connecting the Cerros de San Lucas, west of the river, with the Sierra de Santa Marta, crossing the course of the Magdalena near El Banco, where they outcrop on both sides of the river in low hills.

West of the river the marine Tertiary deposits are in part bordered on the south by crystalline rocks in the San Lucas and Ayapel ranges, and on the west in part by similar rocks in the San Jeronimo range, which also occur at a few scattered points, as in the Cerro de Maco. Cretaceous beds occur in contact with marine Tertiary about the Santa Marta range and at a few other localities west of the Magdalena, judging from lithology. For the most part the basement rocks are either Cretaceous or older, possibly including some of Paleozoic age not yet recognized as such. Volcanic rocks older than the Tertiary have also been described in the western Cordillera, and in the Sierra de Perija.

#### EOCENE DEPOSITS

The Eocene deposits within the drainage areas of the Magdalena illustrate better than any other the three distinct facies of deposition, since they include not only marine deposits well characterized by faunas, but also non-marine, or lacustrine deposits far in the interior, and in intervening stations where the drainage found exit from the interior, there are partly marine, or estuarine deposits, also characterized by a fauna of brackish water aspect, with no clearly marine species, but associated with veins of coal and carbonaceous beds, and with petroliferous strata.

*Marine Eocene.* The Eocene deposits of the lower valley of the Rio Magdalena, and westward along the coast to the Gulf of Uraba, are almost entirely marine, if we except certain coal-bearing beds that seem to represent temporary conditions of deposition in the midst of the series. These coal-bearing strata outcrop about San Andres, and appear to underlie much of the San Jorge valley east of the San Jeronimo range.

In the Coloso range east of the Gulf of Morrosquillo, and in the higher hills west of the Sinú valley, as in the Cerros de las Palomas, there are cherts limestones and hard sandstones of the type found about San Andres and the Cerro de Tofeme, that doubtless belong in the Eocene. Between Lorica and Monitos, near the village of San Blas, an outcrop of rusty gray or yellowish sandstone contains numerous Eocene types of Mollusca, such as *Venericardia*, *Turritella*, *Ostrea*, etc.

This sandstone is clearly associated with the cherts and limestones of the Cerros de las Palomas.

*El Carmen section.* In southern Bolivar a general section of the Lower Tertiary deposits was made, extending from the basal beds near Cansona, by way of El Carmen eastward toward Zambrano on the Magdalena. In this section the proved Eocene constitutes at least 4,500 feet of strata, or a little more than two-thirds of the Lower Tertiary below the known Miocene deposits. The known Eocene begins on the west at a pronounced fault scarp, which a little farther north exposes older crystalline rocks in the Cerro de Maco, while toward the east it is covered by later Tertiary beds including Miocene and possibly Oligocene deposits. The Eocene series shown in this section may be roughly divided into the following subdivisions or zones, as heretofore described<sup>1</sup>:

	<i>Thickness (Feet)</i>
G,—Clay shale, sandy clay shale, white siliceous shale, probably organic; not known to be the top. ....	1,000
F,—Concretionary sandy shale, sandstone, etc., with molluscan fossils, foraminifera, petrified wood, etc. ....	600
E,—Yellow thin-bedded sandstone, weathering red. ....	400
D,—Whitish shale, with lenses and thin beds of limestone, etc., (Tofeme member) with thin beds of lignite and carbonaceous matter near bottom). ....	300
C,—Earthy or hard, thin-bedded, siliceous shales, marly shale, limestone, etc., containing molluscan fossils. ....	800
B,—Yellow concretionary sandstone. ....	500
A,—Heavy beds of sandy conglomerate (near Cansona) with boulders of sandstone, chert and eruptive rocks of dioritic nature, all well rounded. ....	400
<b>Total</b> .....	<b>4,500 feet</b>



Fig. 1.

Fig. 1. East to west sectional sketch through El Carmen. Horizontal scale, 1 inch = 3.4 miles; vertical scale, X 6.8.

<sup>1</sup> Anderson, F. M., Bull. Am. Assoc. Petr. Geol., Vol. 10, 1926, p. 390.



*Structure.* The structure of these beds is shown in the accompanying profile, which crosses two or more anticlinal folds, the central being the most prominent and extensive. It is traceable for nearly 100 miles in a direction of N. 30° E., from near San Andres northward to Calamar. Where the section crosses this fold two miles west of El Carmen it is deeply cut by erosion, exposing three or more of the upper members of the foregoing series. West of the axis of this fold the beds sink in a syncline that may be co-extensive. Toward the north it extends to an unknown distance, possibly to Calamar, and southward it may find its continuation in the Sincelejo syncline described by Beck<sup>2</sup> near San Andres.

Throughout most of its course this trough is occupied by later beds which cover the known Eocene. In places these may be Oligocene in age, but in other places they are certainly Miocene. However, these superimposed beds are not always in contact with the same horizon of the Eocene. Denudation evidently followed the folding of the Eocene series.

West of the syncline in the Carmen section the entire Eocene series rises in a high monoclinal range of hills (1800 ft. ?), the west slope of which represents the great fault scarp mentioned before. Near San Juan the series is faulted along a parallel line nearer the syncline, but rises farther west upon the crystalline rocks of the Cerro de Maco. The fault line passing near Cansona extends northward toward Calamar, and southward forms the west escarpment of the Coloso range facing the Gulf of Morrosquillo, and with some offsets may be followed by the way of Palmito into the Sinu valley far above Monteria. This has been called the "Bolivar fault."

*Molluscan fauna.* The fauna of the marine Eocene series can be only partially given at present, though a sufficient number of determinable species was found to indicate the stratigraphic position of some of the beds in the general section of the Andean Eocene, and perhaps that of the Gulf coast and of western Europe.

From horizon F, in the upper part of the series, and overlying the red beds of horizon E, a limited fauna was obtained from a point some six miles southwest of El Carmen, on the

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<sup>2</sup> Beck, Alfred, Econ. Geol., Vol. 16, 1921, pp. 464-467.

west flank of the high anticlinal ridge, which contained the following species:

<i>Aturia colombiana</i> , n. sp.	<i>Ostrea</i> cf. <i>Alabamiensis</i> Lea
<i>Crassinella</i> ( <i>Gouldia</i> ) <i>minuta</i> , n. sp.	<i>Cerithiopsis</i> , sp.
<i>Cardium</i> cf. <i>triangulatum</i> de Laub.	<i>Pseudoliva</i> sp.
<i>Venericardia alticosta</i> (?) Conrad	<i>Phos</i> sp.
<i>Corbula</i> sp.	<i>Numulites carmenensis</i> , n. sp.

The numuloid foraminifera occur here in great numbers in a concretionary bed of sandstone containing also some molluscan species. Overlying this are sandy shales with layers of sandstone containing the large oysters, the valves of which as seen in fragments are more than two inches in thickness and perhaps a foot in length.

West of the syncline this horizon rises at the foot of the monoclinical range a little below Caracoli, and is identifiable not alone by its fauna, but also by its relation to the underlying red bed. At a point about six miles west of El Carmen, a considerable fauna was collected from concretionary beds in sandy shale, though the collection is far from being exhaustive. It includes some of the species found at the former locality and many others, a list of which with the appropriate citations to the literature follows on another page. It may be worth recording that with these fossils were found fragments of carbonized wood and much shell débris. Many genera and species were observed in the field, some of which were not collected, and the list includes a few of these, especially a form of *Venericardia planicosta* Lam.

In horizon C of the Carmen section, a mile or more north of Caracoli were found a number of fossils in a calcareous sandstone, including a *Dosinia*, *Mactra*, *Crassatellites* (?), and *Venericardia*, near *V. planicosta*.

Horizon F has been found at other neighboring places both north and south of El Carmen, as near San Jacinto, and at Las Palmas. Species of *Clavilithes*, *Volutospira*, *Turritella* and other genera are common in this horizon. Foraminifera, to be described later, characterize these beds in all of the observed outcrops, and were found at a depth of 900 feet in the well drilled three miles south of San Jacinto by the Standard Oil Company of California.

Another locality found near Arroyo Hondo by John H. Ruckman in 1914 contains numerous molluscan species, including *Venericardia* rel. *planicosta* and foraminifera which Dr. T. W. Vaughan has regarded as probably Eocene.<sup>3</sup> The horizon exposed here is believed to be about that of F in the Carmen section, and it is underlaid by a great thickness of Tertiary shale.

*List of fossils found six miles west of El Carmen, Department of Bolívar, Colombia*

GASTROPODA

1. *Actæon* (*Tornatellæa*) cf. *quercollis* HARRIS, 1896; Bull. Am. Pal., Vol. I, No. 4, p. 747 (188); Midway group.
2. *Akera bolivarensis*, n. sp.; Horizon F.
3. *Amauropsis perovata* (CONRAD), 1846; Proc. Acad. Nat. Sci. Phila., Vol. 3, p. 21, pl. 1, fig. 16.—HARRIS, Bull. Am. Pal., Vol. 1, No. 1, p. 49, pl. 1, fig. 4; Claiborne group.
4. *Ancilla* (*Olivula*) cf. *scamba* (CONRAD), 1833; Foss. Shells Tert. Form., Vol. 1, No. 2, p. 25, pl. 10, fig. 4; Claiborne group.
5. *Ancilla* (*Olivula*) *staminea* (CONRAD), 1832; Foss. Shells Tert. Form., Vol. 1, No. 2, p. 25, pl. 10, fig. 5; Claiborne group.
6. *Athleta* (*Volutospina*) cf. *petrosa* (CONRAD), 1835; Foss. Shells Tert. Form., Vol. 1, No. 3, p. 29; 2d Ed., p. 41, pl. 16, fig. 2; Claiborne group.
7. *Athleta* (*Volutospina*) *caracoli*, n. sp.; Horizon F.
8. *Cadulus* sp.
9. *Calyptrea* cf. *aperta* (Sol.) HARRIS, 1899; Bull. Am. Pal. Vol. 3, No. 11, p. 84, pl. 11, figs. 13-16; Wilcox group.
10. *Cerithiopsis conica* ALDRICH, 1897; Bull. Am. Pal., Vol. 2, No. 8, p. 178, pl. 1, fig. 4; Claiborne group.
11. *Clavilithes* cf. *harrisi* WOODS, 1922; Geol. and Pal. N. W. Peru, p. 97, pl. 13, fig. 6; *Clavilithes* series.
12. *Dentalium samanicum* BERRY, 1926; Nautilus, Vol. 40, No. 1, pp. 19-20, text figs.; ? Negritos group.
13. *Dentalium* sp.; Horizon F.
14. *Eulima* ? sp.; Horizon F.
15. *Levifusus* cf. *pagoda* (HEILPRIN), 1880; Proc. U. S. Nat. Mus., Vol. 3, p. 149, pl. 1, fig. 1; Eocene, Alabama.—HARRIS, 1896, Bull. Am. Pal. Vol. 1, No. 4, p. 207, pl. 9, fig. 8; Wilcox group.
16. *Lysis* GABB., sp. not known; Calif. Pal., Vol. 1, p. 138; Eocene.
17. *Natica aperta* WHITFIELD, 1865; Am. Jour. Conch., Vol. 1, p. 265.—HARRIS Bull. Am. Pal., Vol. 3, No. 11, p. 90, pl. 11, fig. 27; Wilcox group.

<sup>3</sup> Vaughan, T. W., Bull. U. S. Nat. Mus. No. 103, 1919, p. 197.

18. *Natica* cf. *eminula* CONRAD, 1833; Foss. Shells Tert. Form., Vol. 1, No. 2, p. 46—HARRIS, Bull. Am. Pal., Vol. 1, No. 4, p. 233, pl. 12, fig. 20.
19. *Olivancillaria* cf. *peruviana* WOODS, 1922; Geol. and Pal. N. W. Peru, p. 106, pl. 16, figs. 5-6; Lobitos group.
20. *Pseudoliva*, sp.; Horizon F.
21. *Pyrula* cf. *juvensis* WHITFIELD, 1865.—HARRIS, Bull. Am. Pal., Vol. 1, No. 4, p. 216, pl. 10, figs. 5-6; Claiborne group.
22. *Rostellaria* (*Cowlitzia*) rel. *canalifera* (GABB), 1864;—GABB, Calif. Pal. Vol. 1, p. 123, pl. 29, fig. 228; Tejon group.
23. *Sigaretus* cf. *bilix* CONRAD, 1833; Am. Jour. Sci., Vol. 23, p. 344.—HARRIS, Bull. Am. Pal. Vol. 1, No. 1, p. 7; Claiborne group.
24. *Solariella* cf. *louisiana* DALL, 1893; Trans. Wag. Fr. Inst., Vol. 3, p. 407, pl. 23, fig. 1; Wilcox group.
25. *Surcula* (*Drillia*) *carmenensis*, n. sp.; Horizon F.
26. *Terebra* cf. *plicatula* LAMARCK;—COSSMANN and PISSARRO, Iconog. Coq. foss. l'Eocene, etc., Vol. 2, pl. 53, figs. 231-1; Lute-Barton.
27. *Teinostoma subangulata* (MEYER), 1886.—HARRIS, 1899, Bull. Am. Pal. Vol. 3, No. 11, p. 101, pl. 12, figs. 20-22; Wilcox group.
28. *Turritella humerosa* CONRAD, 1835; Trans. Geol. Soc. Penn., p. 340, pl. 13 fig. 3.—HARRIS, Bull. Am. Pal., Vol. 1, No. 4, p. 224, pl. 11, figs. 10-13; Claiborne group.
29. *Turritella obruta* CONRAD, 1833; Foss. Shells Tert. Form. p. 45; 2d Ed. p. 45, pl. 15, fig. 12; Claiborne group.

## PELECYPODA

30. *Acila ovula* (LEA), 1833; Cont. Geol., p. 80, pl. 3, fig. 59.—HARRIS, 1896, Bull. Am. Pal. Vol. 1, No. 4, p. 168, pl. 4, fig. 5; Midway group.
31. *Arca rhomboidella* LEA, 1833; Cont. Geol., p. 74, pl. 2, fig. 52.—HARRIS, 1919, Bull. Am. Pal. Vol. 6, No. 31, p. 51, pl. 21, figs. 11-17; Claiborne group.
32. *Callista* (*Macrocallista*) *dickersoni* WOODS, 1922; Geol. and Paleont. N. W. Peru, p. 71, pl. 4, figs. 6a-6b; Clavilithes series.
33. *Cardium* aff. *triangulatum* DE LAUB.—COSSMANN & PISSARRO, Iconog. Coq. foss. de l'Eocene, etc., pl. 18, fig. 69-20; Lutetian stage.
34. *Corbula* cf. *arnoldi* WOODS, 1922; Geol. and Paleont. N. W. Peru, p. 74, pl. 5, figs. 7, 8, 8a; Turritella series.
35. *Corbula alabamensis* LEA, 1883; Cont. Geol. p. 451, pl. 1, fig. 12, etc.—HARRIS, 1919, Bull. Am. Pal. Vol. 6, No. 31, p. 185, etc.; Claiborne group.
36. *Cytherea perovata* CONRAD, 1833; var. *Aldrichi* HARRIS, 1895, Bull. Am. Pal., Vol. 1, p. 48, pl. 1, fig. 1; Claiborne group.
37. *Glycymeris caracoli* ANDERSON, n. sp.; Horizon F.
38. *Mactra parilis* CONRAD, 1833; Foss. Shells Tert. Form., Vol. 1, No. 3, p. 68, pl. 19, fig. 8; Claiborne group.

39. *Tellina greggi* HARRIS, 1897; Bull. Am. Pal. Vol. 2, No. 9, p. 264, pl. 14, fig. 19; Wilcox group.
40. *Tellina* cf. *rostralis* (LAMARCK.) COSSMAN and PISSARRO, Iconog. Coq. foss. de l'Eocene, etc., Vol. 1, pl. 5, fig. 35-2; Bartolian stage.
41. *Tellina* cf. *subtriangularis* ALDRICH; Bull. Am. Pal., Vol. 1, No. 2, p. 70, pl. 5, figs. 8, 8a; Eocene.
42. *Venericardia alticosta* CONRAD, 1833; Am. Jour. Sci., Vol. 23, p. 342; Claiborne group.
43. *Venericardia* rel. *planicosta* LAMARCK; WOODS, 1922, Geol. and Paleont. N. W. Peru, p. 66, pl. 4, figs. 1-4; Clavilithes series.
44. *Venericardia* cf. *subrotunda* (CONRAD), 1847-50; Jour. Acad. Nat. Sci. Phila. Vol. 1, p. 129, pl. 14, fig. 11; Eocene.
45. *Volupia boliviensis*, n. sp.; Horizon F.

## CORAL

46. *Stephanocenia peruviana* VAUGHAN, 1922; Geol. and Paleont. of N. W. Peru, p. 133, pl. 23, figs. 1, 1a, etc.; Clavilithes series.

## FORAMINIFERA

47. *Numulites carmenensis*, n. sp.; Horizon F.

## CRUSTACEA

48. *Xanthopsis* (?) sp.; Horizon F.

*Correlation.* The total thickness of the proved Eocene section of Colombia, as seen west of Carmen, greatly exceeds that of the Gulf Coast states and is nearly double in volume. It is considerably less, however, than the estimated thickness of the Negritos formation described by Bosworth<sup>4</sup> for the region of northwest Peru, which he divides into two faunal series, dominated respectively by the genera Clavilithes and Turritella. Above the Negritos formation which is estimated at 7,000 feet is found the Lobitos, the thickness of which is given as 5,000 feet, all of which are included in the Eocene.

The Clavilithes series alone, which seems to be the most characteristic as well as the thickest group, is estimated at 4,000 feet. In the Carmen section of Colombia the only part which thus far affords any criteria for direct correlation is horizon F, beneath which there is a total of about 2,900 feet of strata; in the midst of this appear the lignitic beds of horizon D. Lithologically the Colombian section can not be satis-

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<sup>4</sup> Bosworth, T. O., Geol. and Pal. N. W. Peru, pp. 17 and 23.



factorily compared with that of Peru, although shales predominate in both, with only a minor proportion of sandstones.

It will be noted in the foregoing list of species from horizon F that many of them have been identified with forms found in the *Clavilithes* series, as described by Woods.<sup>5</sup> Several of them have also been compared to, or identified with, Claiborne species of the Gulf Coast, while a few of them are found also in older groups. The Negritos formation is compared by Woods with the Wilcox and the lower Claiborne groups. It would appear from these facts that horizon F may represent a part of the *Clavilithes* series, and belongs somewhere in the Claiborne group, while the lower horizons find their place in the Wilcox, and therefore in the lower part of the Negritos formation.

In a recent short paper, Werenfels,<sup>6</sup> referring to the Tertiary section near Tolu Viejo, east of the Gulf of Morrosquillo, describes a group of strata under the name "Toluviejo Series" which he refers to an upper Eocene horizon upon the basis of foraminifera contained therein. The diagram below represents the present author's interpretation of the section compared to that of Werenfels and Beck<sup>7</sup> for the Tertiary column of northern Colombia.

*Estuarine deposits.* In the central valley of the Magdalena, as in the district of the lower Sogamoso, a great series of strata has been found, which, upon stratigraphic evidence, is to be correlated with the marine Eocene described above, or possibly in part with Oligocene strata, although the latter are not proved to be greatly developed in the nearby marine province of the Tertiary. This series of strata contains a brackish water fauna in its lower part, and beneath it veins of coal and carbonaceous beds, where it rises upon the flanks of the Cerro de la Paz at the eastern border of the valley. Hettner classed this series with his Guaduas Beds,<sup>8</sup> although he regarded it as of Cretaceous age. Some American geologists<sup>9</sup> have since applied the name "La Paz Beds" to the series, but to the writer

<sup>5</sup> Woods, H., (Op. cit.) pp. 52-56.

<sup>6</sup> Werenfels, A., *Eclogæ geol. Helvit.*, Vol. 20, 1926, pp. 79-83.

<sup>7</sup> Beck, Alfred, *Econ. Geol.*, Vol. 16, 1921, p. 463.

<sup>8</sup> Hettner, A., *Die Kordillere von Bogota*, 1892, Appendix 8c.

<sup>9</sup> Huntley, L. G., *Trans. Am. Inst. Min. & Met. Eng.*, Vol. 68, 1922, p. 1014, etc.

INTERPRETATION OF INDEPENDENT SECTIONS OF THE TERTIARY  
IN NORTHERN COLOMBIA

Elfred Beck	A. Werenfels	F. M. Anderson	
	Sincelejo sandstone	Pliocene	
	— Unconformity —	— Unconformity —	
San Antonio sandstone Formation 1500 feet	Savana sandstone 3937 feet		MIOCENE
		Miocene series 4000 feet, or more.	
Huertas limestone series 1000 feet	Cerrito Formation 3937 feet		
Bombo shales, 500 feet  (and other supposed Oligocene beds)	Pacini shales 3280 feet	Hard gray shale; sandstone and conglomerate ? 2000 feet	? OLIGOCENE
(Unconformity)		Unconformity	
	Toluviejo series 1312 feet	Horizon G, 1000 feet	
	Arroyo seco Formation	Horizon F, 600 feet	EOCENE
		Horizon E, 400 feet	
Tofeme Formation 1500 feet		Horizon D, 800 feet	
		Horizon C, 800 feet	
		Horizon B, 500 feet	
Palmito limestone 200 feet		Horizon A, 400 feet	

it appears better to still use the name first proposed by Hettner. The thickness of the series as found on the Sogamoso, the tributaries of the Rio Colorado, and southward has been given as 10,000 feet or more, though it is not known that this estimate does not include beds later in age than the Guaduas. In this district the series for the most part is sandy, becoming more shaley near the bottom. The coal veins and carbonaceous beds are entirely within the shale group which constitutes perhaps a third of the series. The coal veins are overlaid by dark clay shales several hundred feet in thickness, in which are found molluscan species of brackish water character, including *Melania*, *Ampullaria*, *Corbula*, *Cyrena*, etc. As yet no description of this fauna has appeared, though large collections have been made at various places. Another feature of this series that may have some correlative value is the occurrence in it of petroliferous strata, which are believed by the writer to be indigenous, and to furnish all the production of oil obtained in this district.

The Guaduas series rises on the Cerro de La Paz to an altitude of 2,500 feet or more, carrying the coal veins which have been mined here in a small way. The series rests unconformably upon Guadalupe and older Cretaceous strata as has been proved in other districts.

*Upper valley.* In the upper valley of the Magdalena the Guaduas series has a great development along the west foot of the east cordillera, where it has suffered much folding and faulting; this has exposed here also the coal veins and carbonaceous beds near its base. The beds are similar in all essentials to those of the Rio Colorado and the lower Sogamoso.

Not far above the coal veins near San Juan de Rio Seco Messrs. Downs McCloskey and Thomas Wark found a horizon of brackish water Mollusca which contained among others the following species:

*Melanella karsteni*, n. sp.

*Ampullaria guaduasensis*, n. sp.

*Corbula hettneri*, n. sp.

*Corbula cebada*, n. sp.

*Corbula scheibei*, n. sp.

Carbonized wood, etc.

Other forms, not identifiable, were also found. The material was a dusky gray shale, somewhat fractured and stained

in the joints with iron oxide, though not containing much iron elsewhere. In this district also the Guaduas beds rest upon Guadalupe unconformably, as has been shown by Dr. Robert Scheibe<sup>10</sup> for the district of Tocaima a little to the south. In both the central and upper valleys of the Magdalena the Guaduas beds are overlaid by thick aggregates of strata presumably of Miocene age. In the central valley this series is known as the "Oponcito" series, and in the upper valley the name "Barzalosa" beds has been used to designate its equivalent. Plant beds near Santa Ana, apparently at the base of the series, have furnished numerous species which Berry<sup>11</sup> has referred to the Miocene. This assignment seems to meet stratigraphic requirements.

The relation of the Guaduas beds to the Cretaceous below, and to overlying beds which are here referred to the Miocene, both in the central and upper valleys of the Magdalena, would imply its lower Tertiary age; but since the marine Tertiary, as shown later, contains little Oligocene, but an abundance of Eocene, it is presumable that the Guaduas represents the latter rather than the Oligocene.

*Lacustrine deposits.* On the high plateau of the eastern cordillera, not only in the Sabana de Bogata, but in other similar and somewhat connected valleys, Guaduas beds occur enclosing coal veins and carbonaceous strata though as far as known no marine or brackish water faunas. In this region they are believed to be entirely lacustrine in origin, and are not overlaid by later beds of Miocene age. If the Barzalosa series has any representation on the plateau it has not been shown.

On the eastern slope of the cordillera, in the drainage area of the Orinoco, Guaduas beds have been described by Hettner,<sup>12</sup> as at Medina and farther north, though no mention is made of any Mollusca in them.

Coal-bearing beds of Eocene age are well known in the basin of Maracaibo Lake where they are petroliferous. Here, however, they are said to contain Eocene foraminifera, and

<sup>10</sup> Scheibe, R., Doc. de la Com. Cient. Nac., 1922, pp. 155-177.

<sup>11</sup> Berry, E. W., Bull. Geol. Soc. Am., Vol. 35, 1924, p. 782.

<sup>12</sup> Hettner, A., Die Kordillere von Bogata, 1892, Appendix 6-c.

are therefore marine, in part at least, and may perhaps be the equivalent of the coal bearing marine Eocene series of Colombia.

### OLIGOCENE DEPOSITS

In view of the fact that Oligocene rocks occur in considerable volume in neighboring countries and on some of the islands of the West Indies, they should be expected to appear also in Colombia, at least in the marine province of the Tertiary. So far there has been only meagre evidence of their occurrence here.\* Limestones with numerous species of foraminifera have been found, as on the tributaries of the Rio Sinú near Tolu Viejo, at San Andres, and in the higher hills north of Arenal, Bolivar, and no doubt in other Departments. Most of the authentic determinations of these, however, have shown them to be upper Eocene. Some samples taken from San Andres have been pronounced by Vaughan to be Oligocene in age, but the strata in this section thus proved to belong to this period appears to be limited to a few hundred feet, perhaps including the "Bombo shales" of Elfred Beck. Thus far no other authentic report of Oligocene in this country has appeared, though the period seems to be well represented in the Canal Zone and in the Maracaibo basin. In the section drawn by Werenfels the Oligocene is doubtfully represented by a group of beds to which this author gives the name "Pacini shales," and to which he assigns a thickness of 3280 feet. The Tofeme group of Beck is correlated with a part of the Pacini shales.

It appears to the writer, however, that the Tofeme member belongs much lower in the section and to be really Eocene. Werenfels also places the Bombo shales with the upper part of the Pacini, and immediately following the Tofeme member but it appears to be more in harmony with known facts to suppose an uplift and erosion to have intervened between the two

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\*After the present paper had gone to press the author had opportunity to review the recent work of R. A. Liddle on the Geology of Venezuela. No complete adjustment can now be made of the views expressed herein to the stratigraphic column supplied by Liddle for the Maracaibo region, though this may be attempted as a background to a forthcoming paper on the Later Marine Tertiary Deposits of North Colombia.



groups, by which much of the Eocene may have been removed from the district studied by Beck.

At the west foot of the Coloso range and in the highly folded region west of the Sinú valley between known Eocene beds in the higher ranges and proved Miocene of the coastal border there is a series of somewhat indurated dark clay shales, sandstones and hard conglomerate that is believed to be in part Oligocene. The series may be known as the "Monitos shales," from the predominance in it of this lithologic type.

The relation of the Oligocene to the Eocene strata in Colombia is imperfectly known, and no clear evidence regarding it was discovered in the Carmen section. In the Maracaibo basin, according to Garner,<sup>13</sup> a small angular unconformity exists between Eocene and Oligocene deposits.

According to Liddle\*\* a "marked structural and lithologic unconformity" exists between the lower Oligocene, Pauji formation, and the Eocene of western Venezuela.

In turn also in other places the San Luis limestone (middle Oligocene) rests directly upon Eocene deposits (p.242).

In Santo Domingo the relationship is similar, and according to Cooke<sup>14</sup> a period of diatrophism intervened between the deposition of Eocene and Oligocene deposits.

In the section near Sincelejo, as drawn by Beck<sup>15</sup> the Bombo shales rest immediately upon the Tofeme group of the Eocene, which latter in the Carmen section seems to represent in part horizons C and D, containing the lignitic and carbonaceous beds already mentioned.

As shown by Liddle the "Third coal horizon" in western Venezuela is generally believed to belong in the lower part of the series, and is associated with limestones, as is the case in northern Colombia. (p. 181).

It would appear from the view just given that the period of uplift and denudation following Eocene deposition had removed much of the upper Eocene from parts of the Colombian region as well as from other parts of the Caribbean borders, though perhaps not everywhere equally, before the deposition

<sup>13</sup> Garner, A. H., Trans. Am. Inst. Min. and Met. Eng., Vol. 71, 1925, p. 1364.

\*\*Liddle, R. A. Geology of Venezuela and trinidad (Fort Worth), p. 241.

<sup>14</sup> Cooke, Wythe, A Geological Reconnaissance of the Dominican Republic, (prepared by the U. S. Geol. Surv., 1921, p. 80).

<sup>15</sup> Beck, Alfred, Econ. Geol., Vol. 16, 1921.

of Oligocene. This conclusion will receive even stronger support when we consider the non-marine deposits in the interior of Colombia, where Miocene deposits rest directly upon Eocene, with the entire omission of Oligocene strata, indicating that in these regions the uplift which followed Eocene deposition was prolonged into early Miocene time, or at least until the beginning of this period.

#### DESCRIPTION OF SPECIES

The Tertiary faunas of the northern Andes are imperfectly known at present, since they have been but little studied, and few contributions concerning them have appeared in the literature. The identification of species found in any recent collection must be made very largely without the aid of others authoritatively studied, and with but little aid from the literature covering the region itself. However, the geographic relation of the Andean region to the West Indies and to the nearer states during Tertiary times permits the faunas of these regions and their literature to be used for comparison and identification.

Good collections from the Eocene of Alabama, Texas and other states have been accessible in the present study, and much reliance has been placed upon the literature of the Gulf Coast province, the relationship of which to that of western Europe is well known. Among the more recent contributions covering the Eocene of the Andean region itself, may be mentioned the *Geology and Paleontology of Northwest Peru* by T. O. Bosworth, and the descriptions therein by Woods, Vaughan, Cushman and others, and a later short paper by Hanna and Israelsky.<sup>16</sup> Besides descriptions of numerous Eocene species, the former of these contains many references to earlier publications, and the latter a check-list of Peruvian Tertiary species and citations to literature, both of which are especially helpful, and have been relied upon as being the most trustworthy and convenient keys to the Eocene species of Colombia.

Several molluscan species found in the marine and estuarian provinces of the Rio Magdalena are new, and therefore in

<sup>16</sup> Hanna, G. D., and Israelsky, M. C., *Proc. Calif. Acad. Sci.*, 4th Ser., Vol. 14, No. 2, 1925, pp. 37-72.

themselves little aid in horizon determination, although their association with better known forms is at least corroborative, and will be useful in later work in this region.

### 1. *Aturia colombiana* Anderson, new species

Plate 1, figure 10, text figures 2, 3

Shell of moderate size; robust, dimensions as given in text-figure; aperture oval, wider than high, sides a little expanded below middle; shell involute, umbilicus small, or closed; sutures as shown in figures, strongly reflexed above middle of coil; surface marked by strongly recurved lines of growth.

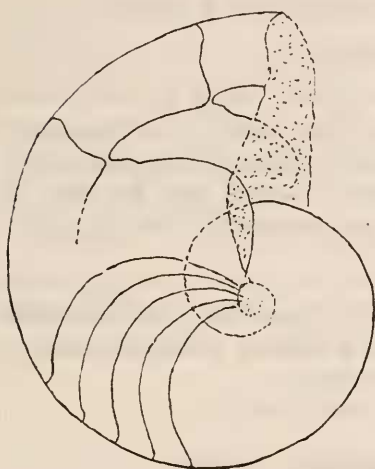


Fig. 2

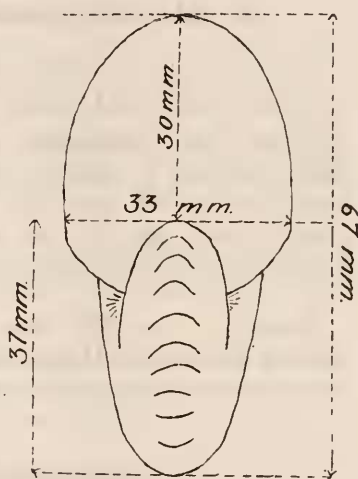


Fig. 3

Figs. 2, 3. Drawings of holotype specimen of *Aturia colombiana* Anderson, new species. Height of figured specimen, 67 mm.; greatest width, 33 mm.

This species is clearly allied to, and may be identical with, *Aturia vanuxemi* (Conrad) from the Eocene of South Carolina. The sutural features of the two species are extremely alike. The sectional drawing of Conrad's<sup>17</sup> figure 17, shows his species to be less rounded, and more sphenoidal in section.

<sup>17</sup> See Jour. Acad. Nat. Sci. Phila., Vol. 1, 1847-50, p. 129-30, pl. 14, figs. 15, 17.

When compared to *A. angustata* Conrad, its nearest ally on the Pacific Coast, from the Miocene (Oligocene?) of Astoria, Oregon, several good examples of which are in the Academy from that vicinity, *A. colombiana* is seen to be larger and more robust, with sutural differences, that while evident, yet clearly show relationship. The species is less closely related to any other known to the writer, being distinct from all of the California forms thus far discovered.

*Holotype*: No. 2697, Mus. Calif. Acad. Sci., from **six miles southwest of El Carmen, Bolivar, Colombia**, horizon F, of the Carmen section of the Eocene.

## 2. *Akera bolivarensis* Anderson, new species

Plate 1, figures 1, 2

Form of shell oval, robust, elongated, length 31 mm., width 16.5 mm.; spire truncated, very low; whorls four, separated from the body by shallow sulcus at the top; aperture ovate, narrowing at the top; shell thin, marked only by lines of growth; outer lip thin and entirely separated from the body; surface showing no spiral lines.

*Holotype*: No. 2687, Mus. Calif. Acad. Sci., from **six miles west of El Carmen, Department of Bolivar, Colombia**, horizon F of the Carmen section of the Eocene.

## 3. *Amauropsis perovata* (Conrad)

Plate 1, figure 6

*Ampullaria ? perovata* CONRAD, Proc. Acad. Nat. Sci. Phila. 1846, p. 21, pl. 1, fig. 16.—*Amauropsis perovata* (CONRAD) HARRIS, Bull. Am. Pal., Vol. 1, No. 1, 1896, p. 49, pl. 1, fig. 4.

Shell thin and polished; whorls five or more, rounded; spire high, sloping gracefully to apex, without deep sutures; outer lip simple, though with sharp edge; aperture ovate; surface showing only lines of growth. The shell somewhat resembles *Am. smithiana* Maury, from the lignitic fauna of Trinidad, and also *Natica aperta* Whitfield, as figured by Harris.<sup>18</sup>

<sup>18</sup> Bull. Amer. Paleo., Vol. 3, No. 11, p. 90, pl. 11, fig. 27.

*Plesiotype*: No. 2691, Mus. Calif. Acad. Sci., from **six miles west of El Carmen, Department of Bolivar, Colombia**, horizon F, Carmen section of the Eocene.

#### 4. *Athleta* (*Volutospina*) *caracoli* Anderson, new species

Plate 1, figure 5

Shell small, elongate pyriform; spire low, with nearly even slope, interrupted only by a slightly raised collar which covers the sutures; whorls five in type specimen; entire body whorl covered by prominent rib-like varices, which ascend the spire; on the body whorl these are crossed by spiral threads which form there laterally elongated beads; aperture narrow; outer lip apparently thin, inner lip encrusted, forming a callus which covers part of the body whorl; callus beaded on its outer part.

*Syntypes*: No. 2689, 2690, Mus. Calif. Acad. Sci., from **six miles west of El Carmen, Colombia**, horizon F, of the Carmen section of the Eocene.

This shell resembles *A. (Volutocorbis) scabricula* (Sol.) as illustrated by Cossmann and Pissarro,<sup>19</sup> but it is smaller and more delicate in sculpture.

#### 5. *Clavilithes* cf. *harrisi* Woods

A single imperfect specimen of this species was collected, though others were seen in the field and recognized generically. The single specimen, with most of the spire missing, is about 35 mm. in length and 16 in width. Most of the shell has disappeared, but enough remains to show that the sculpture is simple, resembling that of the species figured by Woods under the above name. In outline also it resembles this species, though no positive identification can be made.

Locality: Six miles west of El Carmen, Bolivar, Colombia, associated with many other species in horizon F, of the Carmen section.

<sup>19</sup> Iconogr. Coq. foss. de l'Eocene, etc., Vol. 2, pl. 43, figs. 205-1.



6. *Surcula (Drillia) carmenensis* Anderson, new species

Plate 1, figures 3, 4

Shell small, turreted and fusiform; length of type 19 mm., width of body whorl 6 mm., height of spire (apex missing) 10 mm.; whorls six in number, not inflated, each rising in a slight collar on the preceding whorl; surface ornamented by spiral threads and lines, a median thread on each whorl being more prominent than the others, and nodose; nodes elongated spirally, showing, even on the cast, spiral lines not of equal strength, the two below the median being stronger than the others; canal long and tapering to a point, marked outwardly by spiral sculpture.

*Holotype*: No. 2688, Mus. Calif. Acad. Sci., from **six miles west of El Carmen, Bolivar, Colombia**, horizon F, Carmen section of the Eocene.

This shell resembles *Pleurotoma denticulata* (Edw.) Harris,<sup>20</sup> from Woods Bluff, Ala., but it is more slender, and the sculpture differs considerably.

7. *Crassinella (Gouldia) minuta* Anderson, new species

Text figures 4, 5

Shell minute, almost microscopic in size, length and height about equal, 0.5 mm.; outline sub-triangular; somewhat inflated, smooth, or showing only lines of growth; cardinal

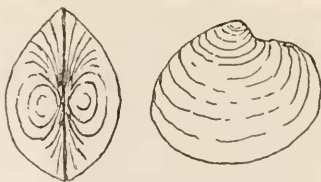


Fig. 4

Fig. 5

Figs. 4, 5. Drawings of holotype specimen of *Crassinella (Gouldia) minuta* Anderson, new species X 12.5. Height of figured specimen, 1.7 mm.; length, 1.8 mm.; width, 1 mm.

<sup>20</sup> Bull. Am. Pal., Vol. 3, No. 11, pl. 1, fig. 21, p. 12.

teeth resembling those of *Astarte*. This shell was found in great numbers associated with *Aturia colombiana* and other marine Mollusca.

*Holotype*: No. 2723; *paratypes*: Nos. 2724-2733, Mus. Calif. Acad. Sci., from six miles southwest of El Carmen, Department of Bolivar, Colombia, horizon F, Carmen section of the Eocene.

### 8. *Glycymeris caracoli* Anderson, new species

Plate 1, figure 9

Shell of medium size, height 20 mm., length 21 mm., thickness 8 mm.; sub-triangular, not much inflated; beaks sub-central, or a little in advance of center; surface ornamentation consisting of concentric ridges, or interruptions of growth crossed by radial ribs that obscure the concentric sculpture; hinge of moderate strength, containing seven to nine cardinal teeth sloping inwardly toward the beak; radial ribs about 35, becoming obsolete near the margin of the shell; ribs rounded, slightly wider than the interspaces; inner margin of the shell crenulated.

*Holotype*: No. 2694; *paratypes*: Nos. 2695, 2696, Mus. Calif. Acad. Sci., from six miles west of El Carmen, Bolivar, Colombia, where it occurs in great numbers.

This shell resembles very closely the figures of *G. ignus* (De Gregorio) but it is less triangular, or more rounded in outline, with sculpture disappearing near the lower margin of the shell. *G. caracoli* may also be compared with *G. trigonella* (Conrad), (and therefore with *G. deltoidus* (De Gregorio), which Harris<sup>21</sup> includes as a synonym), from the Claiborne of the Gulf Coast Eocene.

### 9. *Ostrea* (large species)

No attempt is here made to describe this species, although its unusual size might seem to warrant doing so. Only fragments were found, some of which measured seven inches in length and two inches in thickness of single valves. In size and

<sup>21</sup> Bull. Am. Pal., Vol. 6, No. 31, p. 40.

other characters they recalled the *Ostrea titan* of the California Miocene. The species may be related to *Ostrea alabamiensis* Lea, which, according to Harris, is *Ostrea contracta* of Conrad;<sup>22</sup> this is said to attain a length of nearly two feet.

#### 10. *Venericardia alticostata* Conrad

*Venericardia alticostata* CONRAD, 1833, Amer. Jour. Sci., Vol. 23, p. 342.

Shell of moderate size, sub-quadrate, length 33 mm., height 21 mm., thickness 20 mm.; beaks anterior, lunule small; ribs 20 in number, prominent, ornamentation not simple; ribs slightly grooved on the summit and sides, and having a secondary or intermediary riblet only occasionally. This fluted character of the ribs perhaps distinguishes this form from others, though it is believed not to be specific in value.

The species was found with many others some six miles west of El Carmen, Bolivar, in horizon F, just above the red beds of this section of the Eocene.

#### 11. *Venericardia* rel. *planicosta* Lamarck

This species was recognized in the field but not collected. The shells were fragmentary, for the most part; some appeared to have been four inches in length and relatively thick, with broad smooth ribs similar to those figured by Woods<sup>23</sup> from the "Clavilithes series" of Peru.

#### 12. *Volupia bolivarensis* Anderson, new species

Plate 1, figures 7, 8

Shell small, outline triangular; height 10.1 mm., length 10 mm., thickness of single valve 4 mm.; lunule small; beaks closely approaching each other, depressed, curving forward; surface ornamented by a few strong concentric folds, the central one being much heavier than the others; posterior end bearing a flange-like projection descending from the shell by a deep suture, sculptured by radial and concentric lines, and

<sup>22</sup> See Conrad, Proc. Acad. Nat. Sci. Phila. 1855, p. 269.

<sup>23</sup> Geol. and Paleont. of Northwest Peru, p. 66, pl. 4, figs. 1-4.

bearing a small lateral tooth within; cardinal tooth like *Phacoides*.

*Holotype*: No. 2692; *paratype*: No. 2693, Mus. Calif. Acad. Sci., from six miles west of El Carmen, Bolivar, Colombia, associated with many other species in horizon F of the Carmen section.

This genus has not hitherto been reported from American Eocene beds as far as known, though it has two or three representatives in western Europe.

### 13. *Melanella karsteni* Anderson, new species

Plate 1, figures 21, 22

Shell small, though not minute, stout, tapering; length 11.5 mm. width 5 mm.; spire elongate conical, whorls separated by distinct sutures, last whorl roundly angular; surface white or yellowish, polished, marked by faint lines of growth; aperture ovate, posterior angle not acute, base short; outer lip rounded at juncture with the basal border.

*Holotype*: No. 2722, Mus. Calif. Acad. Sci., from near San Juan de Rio Seco, east border of the upper valley of the Magdalena River, Colombia, from the lower part of the Guaduas beds, not far from horizon of the coal veins.

### 14. *Ampullaria guaduasensis* Anderson, new species

Plate 1, figures 19, 20

Shell of moderate size, length 20 mm., maximum width 16 mm., spire elevated, whorls four or five, flattened above, angulated, sides slightly rounded; surface not well known but apparently smooth; suture not distinct; aperture ovate, pointed behind, rounded in front; outer lip smooth and regular; umbilicus closed by a callus; body whorl flattened above, sloping gently outward to the angulated shoulder.

*Holotype*: No. 2721, Mus. Calif. Acad. Sci.; found with the preceding near San Juan de Rio Seco, on the east border of the upper valley of the Magdalena River, Colombia, in the lower part of the Guaduas beds, not far from the horizon of the coal veins.

**15. *Corbula hettneri* Anderson, new species**

Plate 1, figures 11, 12, 13, 14, text figures 10, 11

Shell of moderate size, length 13 mm., height 15 mm., thickness 10 mm.; variably triangular in outline; beaks high, incurved, closely approaching each other; umbones angulated; shell usually squarely truncated behind, rounded in front; surface marked by strong lines of growth, show-

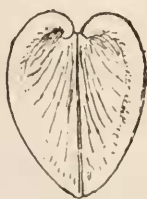


Fig. 10



Fig. 11

Figs. 10, 11. Drawings of syntype specimen of *Corbula hettneri* Anderson, new species X 2. Height, 14.6 mm.; Length, 13.9 mm.; thickness, 10 mm.

ing a few periods of pause in development; sometimes inequivalve, the right valve being slightly larger, with more prominent beak; lunule small, ovate, or broadly lanceolate; prominent cardinal tooth on right valve, forming a sharp angle with posterior margin beneath the beak.

*Syntypes*: Nos. 2698, 2699; *paratypes*: Nos. 2700-2705, Mus. Calif. Acad. Sci.; found with the preceding species near **San Juan de Rio Seco**, on the east border of the upper valley of the Magdalena River, Colombia, near the base of the Guaduas group of brackish water beds.

**16. *Corbula cebada* Anderson, new species**

Plate 1, figure 15; text figures 6, 7

Shell small, length 7.5 mm., height 5.1 mm., thickness 3.6 mm.; outline as shown in the figure, posterior upper margin nearly straight, anterior slightly excavated, lower margin



broadly rounded; slightly inequivalve, inflation moderate; no visible lunule; surface ornamented only with concentric lines of growth; beaks slightly in advance of the center of the shell.



Fig. 6



Fig. 7

Figs. 6, 7. Drawings of holotype specimen of *Corbula cebada* Anderson, new species X 2. Length of figured specimen, 7.5 mm.; width, 3.6 mm.; height, 5.1 mm.

*Holotype*: No. 2706; *paratypes*: 2707-2715, Mus. Calif. Acad. Sci.; near San Juan de Rio Seco, on the east border of the upper valley of the Magdalena River, Colombia, near the base of the Guaduas group, not far from the horizon of the coal veins.

This shell resembles *Corbula cuneata* Say from the Tertiary of Maryland. Without any more definite information as to the horizon and habitat of Say's species no positive identification can be made.

#### 17. *Corbula scheibei* Anderson, new species

Plate 1, figures 16, 17, 18; text figures 8, 9

Shell small, sub-circular in outline, inflated; length 11 mm., height 10 mm., thickness 11 mm.; beaks low, rounded, closely approaching each other; surface smooth, marked only by fine lines of growth. This species resembles somewhat *Corbula galvestonensis* Harris<sup>24</sup> from the deep well drilled near Galveston. This Texas species seems to have come from the Neocene beds of that coast which were probably marine.

This species is named in honor of Dr. Robert Scheibe, who was for some years, and until the time of his unfortunate death, director of the work of the Comision Cientifica

<sup>24</sup> See Bull. Am. Pal., Vol. 1, No. 3, p. 94, pl. 2, figs. 4-4a.



Fig. 8



Fig. 9

Figs. 8, 9. Drawings of holotype specimen of *Corbula scheibei* Anderson, new species X 2. Length of figured specimen, 11 mm.; height, 10 mm.; width, 10 mm.

Nacional in Colombia. He died in 1923 soon after his return from an extended excursion in the eastern cordillera made in pursuance of his duties.

*Syntypes*: Nos. 2716, 2717; *paratypes*: Nos. 2718, 2719, 2720, Mus. Calif. Acad. Sci.; near San Juan de Rio Seco on the east border of the upper valley of the Magdalena River, Colombia, near the base of the Guaduas group, and near the horizon of the coal veins.

#### 18. *Numulites carmenensis* Anderson, new species

Plate 1, figures 23, 24

Test circular, lenticular in section, about four times as wide as thick; discoidal, all chambers being added to periphery; chambers a little longer in radial direction than parallel to circumference; partition walls thin and at outer end turned retractively backward; outer walls of last volution, irrespective of age, with long wing-like projections which extend to central short axis; thus each volution completely covers all preceding, the cover being composed of heavy rounded ridges becoming progressively smaller toward the center; surface smooth and shining. Diameter of holotype 3.4 mm.; diameter of largest one seen, 4.2 mm.; thickness 1 mm.

*Holotype*: No. 2509; *paratypes*: Nos. 2510, 2511, 2512, Mus. Calif. Acad. Sci., from six miles west of El Carmen, Bolivar, Colombia; horizon F of the Carmen section, probably Middle Eocene.

This species is very abundant in hard calcareous sandstone at several different localities. There is considerable difficulty in freeing the specimens from the matrix rock, and there is some indication that when fully mature the test does not present the radially ribbed appearance shown in the photographs, but is coarsely nodose; positive assurance that this is true can not be given because the sand grains adhere tenaciously to the exterior surface.

In 1924 Vaughan<sup>25</sup> listed nine species of *Numulites* which had been recorded from America, and of these he referred all to other genera except *N. parvula* Cushman,<sup>26</sup> from the Eocene of St. Bartholomew, West Indies.

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<sup>25</sup> American and European Tertiary larger Foraminifera. Bull. Geol. Soc. America, Vol. 35, p. 787.

<sup>26</sup> Carnegie Inst. Publ. 291, 1919, p. 51, pl. 4, fig. 3.

## PLATE 1

- Figs. 1, 2. *Akera bolivarensis* Anderson, new species; natural size; holotype, No. 2687 (C. A. S. type coll.), from Horizon "F", six miles west of El Carmen, Bolivar. Eocene; p. 18.
- Figs. 3, 4. *Surcula (Drillia) carmenensis* Anderson, new species; natural size; holotype, No. 2688 (C. A. S. type coll.), from same locality as fig. 1; p. 20.
- Fig. 5. *Athleta (Volutospina) caracoli* Anderson, new species; natural size; syntype, No. 2689 (C. A. S. type coll.), from same locality as fig. 1; p. 19.
- Fig. 6. *Amauropsis perovata* (Conrad); natural size; plesiotype, No. 2691 (C. A. S. type coll.); from same locality as fig. 1; p. 18.
- Figs. 7, 8. *Volupia bolivarensis* Anderson, new species; natural size; holotype, No. 2692 (C. A. S. type coll.); from same locality as fig. 1; p. 22.
- Fig. 9. *Glycymeris caracoli* Anderson, new species; natural size; holotype, No. 2694 (C. A. S. type coll.); from same locality as fig. 1; p. 21.
- Fig. 10. *Aturia colombiana* Anderson, new species; natural size; holotype, No. 2697 (C. A. S. type coll.), from Horizon "F," six miles southwest of El Carmen, Bolivar. Eocene; p. 17.
- Figs. 11, 12, 13, 14. *Corbula hettneri* Anderson, new species; natural size; syntypes, No. 2698 and 2699 (C. A. S. type coll.), from Guaduas beds near San Juan de Rio Seco, upper valley of the Rio Magdalena. Fig. 11, posterior view, showing truncation, and fig. 12 showing exterior view of syntype No. 2698; fig. 13, exterior view of syntype No. 2699; fig. 14 same specimen, showing hinge. Eocene; p. 24.
- Fig. 15. *Corbula cebada* Anderson, new species; X 3; holotype, No. 2706 (C. A. S. type coll.), from same locality as fig. 11. Figure shows form and sculpture of left valve. Eocene; p. 24.
- Figs. 16, 17, 18. *Corbula scheibei* Anderson, new species; syntypes, No. 2716 and 2717 (C. A. S. type coll.), same locality as fig. 11. Fig. 16, syntype, No. 2716, X 3, shows hinge; fig. 17, exterior view of same specimen, X 1.5; fig. 18, syntype, No. 2717, view from above, natural size. Eocene; p. 25.
- Figs. 19, 20. *Ampullaria guaduasensis* Anderson, new species; natural size; holotype, No. 2721 (C. A. S. type coll.), same locality as fig. 11. p. 23.
- Figs. 21, 22. *Melanella karsteni* Anderson, new species; fig. 21 X 1.5; fig. 22 X 1; holotype No. 2722 (C. A. S. type coll.), from same locality as fig. 11. p. 23.
- Fig. 23. *Nummulites carmenensis* Anderson, new species; X 7.5; paratype, No. 2510 (C. A. S. type coll.), from same locality as fig. 1. p. 26.
- Fig. 24. *Nummulites carmenensis* Anderson, new species; X 7.5; holotype, No. 2509 (C. A. S. type coll.), from same locality as fig. 1. p. 26.

